

## Chapter 5

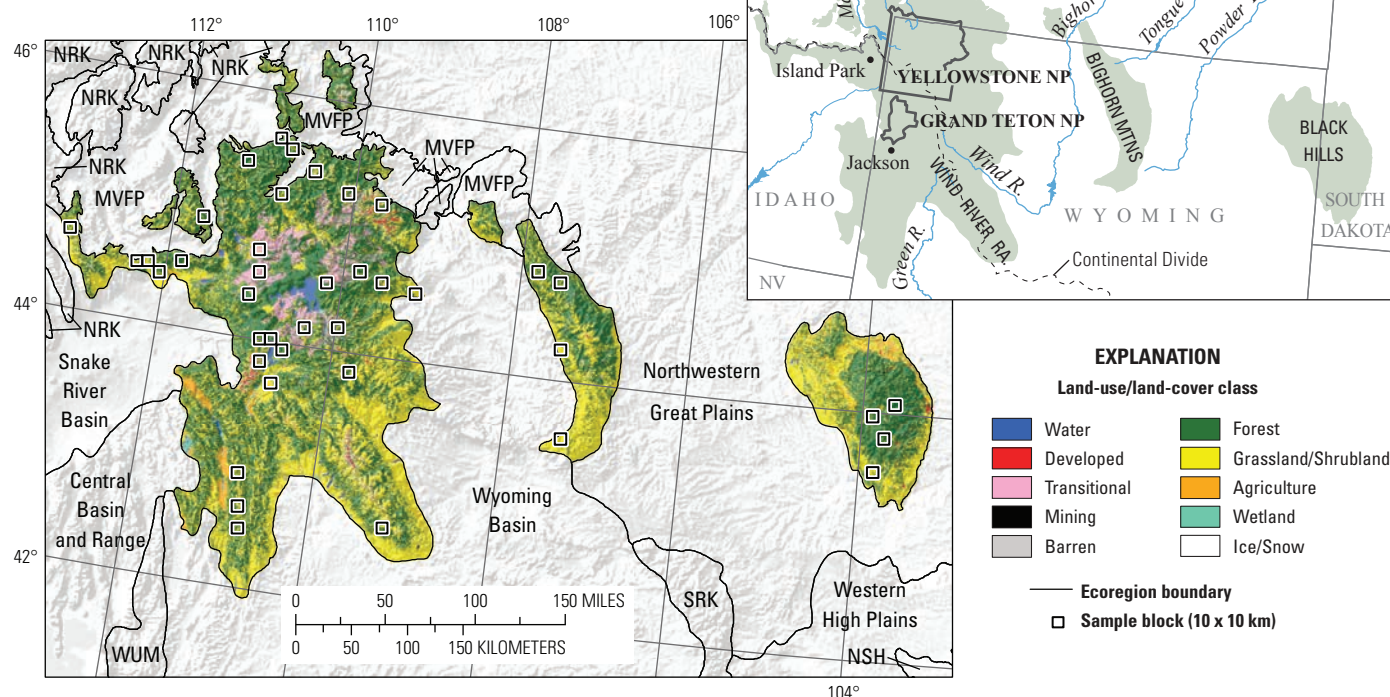
# Middle Rockies Ecoregion

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## Ecoregion Description

The Middle Rockies Ecoregion—characterized by steep, high-elevation mountain ranges and intermountain valleys—is a disjunct ecoregion composed of three distinct geographic areas: the Greater Yellowstone area in northwest Wyoming, southwest Montana, and eastern Idaho; the Bighorn Mountains in north-central Wyoming and south-central Montana; and the Black Hills in western South Dakota and eastern Wyoming (Omernik, 1987; U.S. Environmental Protection Agency, 1997). The ecoregion covers approximately 90,160 km<sup>2</sup> (34,881 mi<sup>2</sup>), and its three distinct geographic sections are bordered by several other ecoregions (fig. 1). The Yellowstone section abuts the Montana Valley and Foothill Prairies and the Northern Rockies Ecoregions to the north, the Snake River Basin and the Central Basin and Range Ecoregions to the west, and the Wyoming Basin Ecoregion to the south and east. The Bighorn Mountains section lies between the Wyoming Basin Ecoregion to the west and the Northwestern Great Plains Ecoregion to the east, and it abuts the Montana Valleys and Foothill Prairies Ecoregion to the north. The Black Hills section is entirely surrounded by the Northwestern Great Plains Ecoregion. The Continental Divide crosses the ecoregion from the southeast along the Wind River Range, through Yellowstone National Park, and west along the Montana-Idaho border. On both sides of the divide, topographic relief causes local climate variability, particularly the effects of aspect, exposure to prevailing wind, thermal

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**Figure 1.** Map of Middle Rockies Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this “Status and Trends of Land Change” study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Squares indicate locations of 10 x 10 km sample blocks analyzed in study. Index map shows locations of geographic features mentioned in text. Abbreviations for Western United States ecoregions are listed in appendix 2. Also shown on map are parts of three Great Plains ecoregions: Northwestern Great Plains, Western High Plains, and Nebraska Sand Hills (NSH). See appendix 3 for definitions of land-use/land-cover classifications.



**Figure 2.** Small alfalfa field and flat to rolling agricultural land at base of forested hills in Middle Rockies Ecoregion. Photograph by Terry Sohl, 2008.

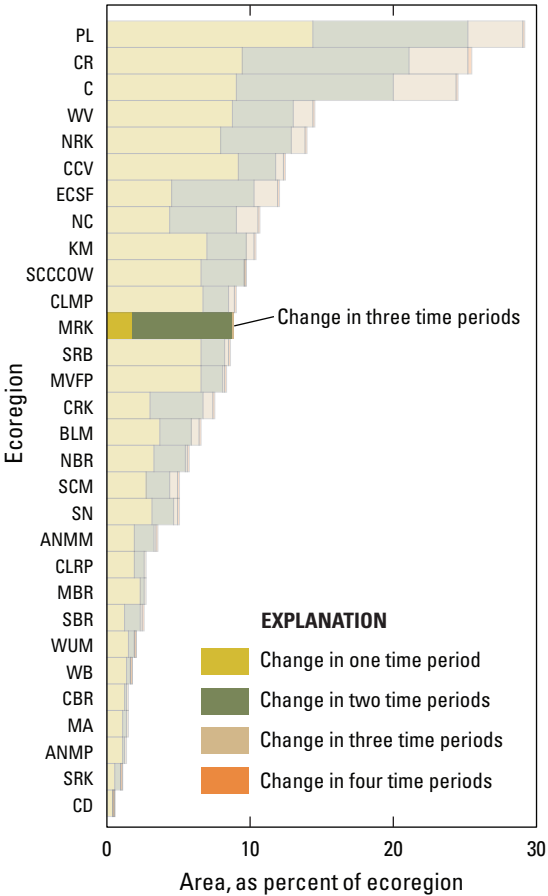


**Figure 3.** Sagebrush (grassland/shrubland) dominates flatter, lower elevation areas west of Interstate 15 in Middle Rockies Ecoregion. Photograph by Terry Sohl, 2008.

inversions, and rain-shadow effects, that are reflected in the wide variety of flora and fauna within the ecoregion (Ricketts and others, 1999).

The three main land uses common to the Middle Rockies Ecoregion are logging, recreation, and agriculture. Agricultural land use within the intermountain valleys includes managed hay fields and pasture lands, irrigated alfalfa, and other scattered crops (fig. 2). Grazing of cattle and sheep occurs in the valleys year-round and on higher elevation open areas in summer. There are ski resorts and destination communities such as the towns of Big Sky, Montana; Jackson, Wyoming; and Island Park, Idaho. Yellowstone National Park and Grand Teton National Park, both in the ecoregion, draw millions of visitors each year. There are nine national forests within the ecoregion that are managed for multiple uses including logging, grazing, and recreation.

Land cover in the valleys is dominated by grassland/shrubland (fig.3). Common grass species include grama grass (*Bouteloua* spp.), wheatgrass (*Eremopyrum* spp.), and needlegrass (*Nassella* spp.). Common shrubs include sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus viscidiflorus*), and serviceberry (*Amelanchier arborea*). Hillsides are mostly forested. Lodgepole pine (*Pinus contorta*) is the most common conifer throughout the Yellowstone area and the Bighorn Mountains, but ponderosa pine (*Pinus ponderosa*) is more common in the Black Hills, which are lower in elevation (Mohlenbrock, 2002). Perennial streams and rivers run through many of the valleys, and riparian vegetation such as cottonwoods (*Populus* spp.) and aspens (*Populus tremuloides*) line the banks. The headwaters for the Yellowstone, Wind, Snake, Powder, Tongue, Green, Madison, and Gallatin Rivers are all within the ecoregion, making it a major source of water for the central United States.



**Figure 4.** Overall spatial change in Middle Rockies Ecoregion (MRK; darker bars) compared with that of all 30 Western United States ecoregions. Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Middle Rockies Ecoregion (three time periods) labeled for clarity. See table 2 for years covered by each time period. See appendix 2 for key to ecoregion abbreviations.

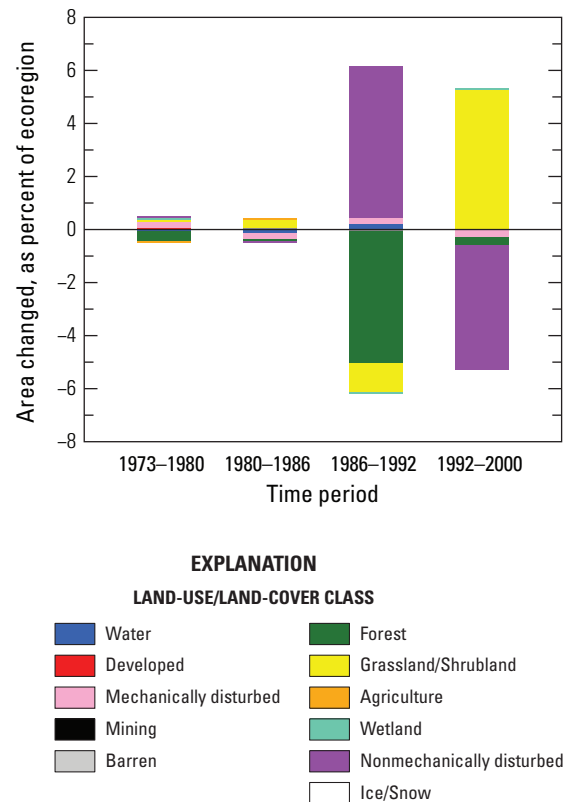
## Contemporary Land-Cover Change (1973 to 2000)

The overall spatial change—the percentage of land area within the ecoregion where land cover changed at least once between 1973 and 2000—was 8.8 percent (7,974 km<sup>2</sup>) (table 1). Of that total, 1.7 percent (1,533 km<sup>2</sup>) changed one time, and 7.1 percent (6,401 km<sup>2</sup>) changed two times. The amount of change in this ecoregion is moderate when compared with all 30 Western United States ecoregions (fig. 4).

Total change in each of the four time periods selected for this study ranged from a low of 0.9 percent (795 km<sup>2</sup>) between 1973 and 1980 to a high of 7.5 percent (6,740 km<sup>2</sup>) between 1992 and 2000 (table 2). After normalizing to an annual rate of change, the rates ranged from a low of 0.1 percent (114 km<sup>2</sup>) per year between 1973 and 1980 to a high of 1.1 percent (1,012 km<sup>2</sup>) per year between 1986 and 1992 (fig. 5).

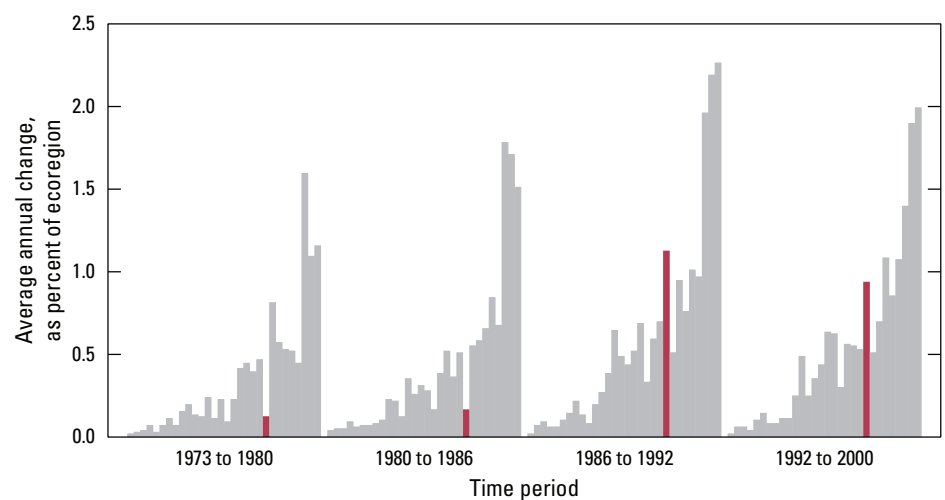
In 1973, forest made up 50.4 percent (45,463 km<sup>2</sup>) of the ecoregion, grassland/shrubland made up 44.4 percent (40,061 km<sup>2</sup>), wetland and agriculture each covered roughly 1.0 percent of the ecoregion, and barren (for example, mountain peaks) covered 2.0 percent (table 3). Forest decreased 11.3 percent by 2000, and grassland/shrubland increased 10.3 percent. In the first two time periods, nonmechanically disturbed land (areas subject to wildfire or insect-caused mortality) never accounted for more than 0.1 percent of the ecoregion, but in the period between 1986 and 1992, that value jumped to 5.7 percent of the ecoregion (5,159 km<sup>2</sup>), largely as a result of the 1988 Yellowstone fires (fig. 6).

Forest to nonmechanically disturbed, nonmechanically disturbed to grassland/shrubland, and grassland/shrubland to nonmechanically disturbed were three of the four largest land-cover conversions (table 4), and all are related to wildfires. Of the 30 sample blocks that were interpreted, 6 showed greater than 20 percent change, and 5 of these were located within the perimeter of the 1988 wildfires (fig. 7). The sixth block with greater than 20 percent change was located in the Black Hills,



**Figure 6.** Normalized average net change in Middle Rockies Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

**Figure 5.** Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Middle Rockies Ecoregion are represented by red bars in each time period.







**Figure 7.** In 1988, Yellowstone area fires caused marked increase in area of nonmechanically disturbed land. Photographs by Terry Sohl, 2008. *A*, Interpretive sign about “Huck Fire,” one of three largest fires to strike Yellowstone area in 1988. In northern part of this sample block, forest along road ends abruptly at edge of burn. *B*, Near “Huck Fire” interpretive sign, forest was completely burned; now, 20-year-old regenerating trees cover much of area. Small marsh area lines stream in foreground.

where the Jasper fire burned in 2000. The fourth most common land-cover change was forest to mechanically disturbed, a result of timber harvest.

The 1988 Yellowstone fires represented by far the largest changes in this ecoregion. The fires followed a prolonged drought and burned more than 3,200 km<sup>2</sup> in and around Yellowstone National Park (Christensen and others, 1989). Dry-lightning storms sparked numerous blazes that converged to become a single major fire. In the decades following the fire, vegetation changes continued, with vigorous herbaceous growth and young forests replacing burned stands of forest (Knight and Wallace, 1989). Lodgepole pines are adapted to fire and produce serotinous cones that respond to fire by opening up to release seed, facilitating forest regrowth.

Additional ecoregion change came from timber harvest in national forests and private forests. One example of such activity is 20 years of salvage logging in Targhee National Forest near Island Park, Idaho, between 1970 and 1990 (Wilkinson, 1999). Large areas were clearcut, right up to the border of Yellowstone National Park, in order to remove beetle-killed lodgepole pine trees. In 1990, the U.S. Forest Service changed their management practices and harvest rates in the Targhee National Forest and in eight other national forests within the ecoregion (Hansen and others, 2002).

**Table 1.** Percentage of Middle Rockies Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (91.2 percent), whereas 8.8 percent changed at least once throughout study period]

Number of changes	Percent of ecoregion	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	1.7	1.0	0.6	2.7	0.7	42.1
2	7.1	3.4	3.7	10.5	2.3	32.2
3	0.0	0.0	0.0	0.1	0.0	50.4
4	0.0	0.0	0.0	0.0	0.0	92.3
Overall spatial change	8.8	3.4	5.4	12.3	2.3	26.5

**Table 2.** Raw estimates of change in Middle Rockies Ecoregion land cover, computed for each of four time periods between 1973 and 2000, and associated error at 85-percent confidence level.

[Estimates of change per period normalized to annual rate of change for each period]

Period	Total change (% of ecoregion)	Margin of error (+/- %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
Estimate of change, in percent stratum							
1973–1980	0.9	0.4	0.5	1.2	0.2	27.2	0.1
1980–1986	0.9	0.4	0.5	1.4	0.3	31.2	0.2
1986–1992	6.7	3.3	3.4	10.1	2.3	33.9	1.1
1992–2000	7.5	3.3	4.1	10.8	2.3	30.5	0.9
Estimate of change, in square kilometers							
1973–1980	795	318	477	1,113	216	27.2	114
1980–1986	856	392	464	1,248	267	31.2	143
1986–1992	6,075	3,019	3,055	9,094	2,057	33.9	1,012
1992–2000	6,740	3,019	3,722	9,759	2,056	30.5	843

**Table 3.** Estimated area (and margin of error) of each land-cover class in Middle Rockies Ecoregion, calculated five times between 1973 and 2000. See appendix 3 for definitions of land-cover classifications.

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grassland/ Shrubland		Agriculture		Wetland		Non- mechanically disturbed	
	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-	%	+/-
Area, in percent stratum																				
1973	0.7	0.5	0.1	0.1	0.2	0.1	0.0	0.0	1.9	0.8	50.4	5.7	44.4	5.7	1.1	0.8	1.0	0.3	0.0	0.0
1980	0.7	0.4	0.2	0.1	0.4	0.3	0.0	0.0	1.9	0.8	50.0	5.7	44.5	5.7	1.0	0.8	1.0	0.3	0.1	0.1
1986	0.5	0.3	0.2	0.1	0.2	0.1	0.0	0.0	2.0	0.8	50.0	5.7	44.9	5.7	1.1	0.8	1.0	0.3	0.0	0.0
1992	0.7	0.5	0.2	0.2	0.4	0.3	0.0	0.0	1.9	0.8	45.0	5.4	43.8	5.7	1.1	0.7	1.0	0.3	5.7	3.3
2000	0.7	0.5	0.2	0.2	0.2	0.2	0.0	0.0	1.9	0.8	44.7	5.2	49.0	5.4	1.0	0.7	1.0	0.3	1.0	1.0
Net change	0.0	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	-5.7	2.7	4.6	2.6	0.0	0.1	0.0	0.0	1.0	1.0
Gross change	0.4	0.6	0.1	0.1	1.5	0.7	0.0	0.0	0.2	0.2	7.6	3.1	7.6	3.9	0.2	0.1	0.1	0.1	12.5	6.7
Area, in square kilometers																				
1973	648	419	96	74	182	135	17	15	1,721	746	45,463	5,170	40,061	5,168	966	725	897	298	0	0
1980	610	378	158	127	380	252	18	15	1,726	749	45,113	5,142	40,161	5,150	932	679	910	307	46	66
1986	473	255	161	130	193	128	18	16	1,788	751	45,081	5,180	40,462	5,126	955	680	909	306	22	32
1992	671	446	173	147	396	233	20	16	1,728	750	40,606	4,890	39,467	5,152	948	664	899	297	5,159	2,993
2000	674	449	174	147	169	139	21	17	1,739	752	40,327	4,674	44,207	4,854	938	663	901	296	937	930
Net change	27	33	78	82	-13	144	4	3	17	16	-5,135	2,425	4,146	2,348	-27	80	4	40	937	930
Gross change	385	505	79	82	1,387	671	4	3	143	162	6,810	2,770	6,865	3,522	165	113	79	73	11,294	6,008

**Table 4.** Principal land-cover conversions in Middle Rockies Ecoregion, showing amount of area changed (and margin of error, calculated at 85-percent confidence level) for each conversion during each of four time periods and also during overall study period. See appendix 3 for definitions of land-cover classifications.

[Values given for “other” class are combined totals of values for other land-cover classes not listed in that time period. Abbreviations: n/a, not applicable]

Period	From class	To class	Area changed (km <sup>2</sup> )	Margin of error (+/- km <sup>2</sup> )	Standard error (km <sup>2</sup> )	Percent of ecoregion	Percent of all changes
1973–1980	Forest	Mechanically disturbed	378	252	172	0.4	47.5
	Mechanically disturbed	Grassland/Shrubland	113	114	77	0.1	14.2
	Mechanically disturbed	Forest	69	74	51	0.1	8.7
	Forest	Nonmechanically disturbed	46	66	45	0.1	5.8
	Agriculture	Developed	36	52	35	0.0	4.5
	Other	Other	153	n/a	n/a	0.2	19.3
	Totals		795			0.9	100.0
1980–1986	Mechanically disturbed	Grassland/Shrubland	233	210	143	0.3	27.2
	Forest	Mechanically disturbed	193	128	87	0.2	22.5
	Mechanically disturbed	Forest	147	149	101	0.2	17.2
	Water	Grassland/Shrubland	79	110	75	0.1	9.3
	Water	Barren	60	81	55	0.1	7.0
	Other	Other	144	n/a	n/a	0.2	16.8
	Totals		856			0.9	100.0
1986–1992	Forest	Nonmechanically disturbed	4,089	2,358	1,606	4.5	67.3
	Grassland/Shrubland	Nonmechanically disturbed	1,068	1,513	1,030	1.2	17.6
	Forest	Mechanically disturbed	394	233	159	0.4	6.5
	Mechanically disturbed	Grassland/Shrubland	174	127	87	0.2	2.9
	Grassland/Shrubland	Water	106	143	98	0.1	1.7
	Other	Other	244	n/a	n/a	0.3	4.0
	Totals		6,075			6.7	100.0
1992–2000	Nonmechanically disturbed	Grassland/Shrubland	4,488	2,538	1,729	5.0	66.6
	Forest	Nonmechanically disturbed	866	861	586	1.0	12.8
	Mechanically disturbed	Grassland/Shrubland	313	223	152	0.3	4.6
	Forest	Mechanically disturbed	169	139	95	0.2	2.5
	Mechanically disturbed	Forest	71	61	41	0.1	1.1
	Other	Other	834	n/a	n/a	0.9	12.4
	Totals		6,740			7.5	100.0
1973–2000 (overall)	Forest	Nonmechanically disturbed	5,024	2,502	1,705	5.6	34.7
	Nonmechanically disturbed	Grassland/Shrubland	4,557	2,602	1,772	5.1	31.5
	Forest	Mechanically disturbed	1,133	610	416	1.3	7.8
	Grassland/Shrubland	Nonmechanically disturbed	1,116	1,512	1,030	1.2	7.7
	Mechanically disturbed	Grassland/Shrubland	833	532	362	0.9	5.8
	Other	Other	1,804	n/a	n/a	2.0	12.5
	Totals		14,466			16.0	100.0

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